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GB 1128688 A US 4563551 A

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# (54) Electrical contacts

(57) An electrical contact is formed by locating a contact forming member (6) in an aperture in a strip member (1) such that an interference fit is formed between the contact forming member (6) and an upstanding rim (3) defining the aperture and press forming the contact forming member (6) to form a contact member within the aperture. The contact forming member (6) is cropped from a length of silver wire of a diameter slightly greater than the diameter of the inner edge of the rim (3). A recess (10) may be provided in the base of the contact member (6), and the strip member (1) may have a step to raise the contact member (6) from the strip surface.

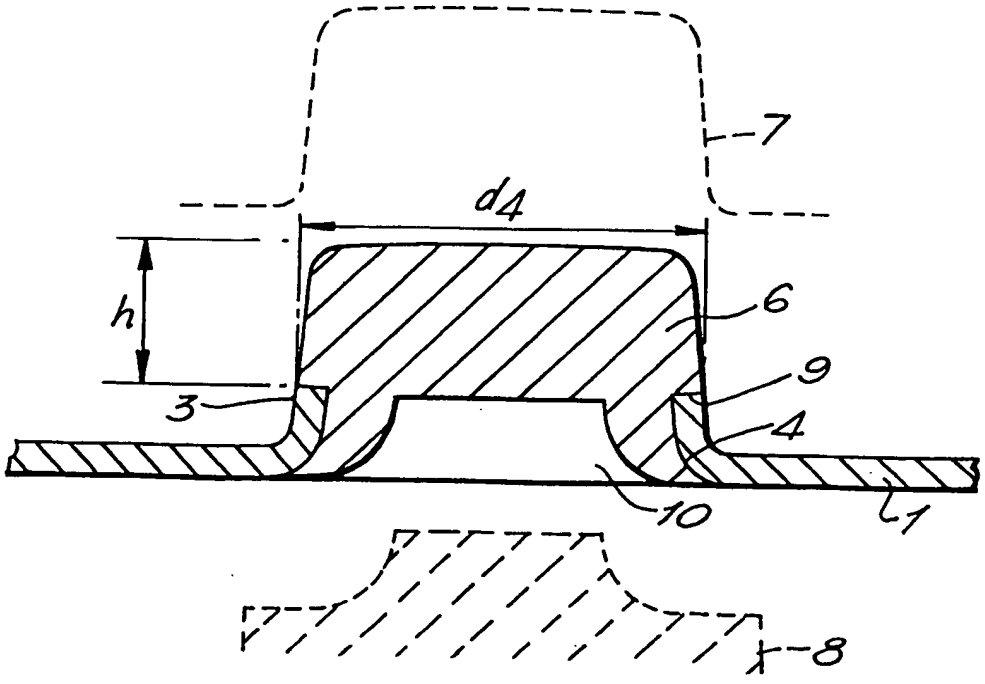


FIG.3.

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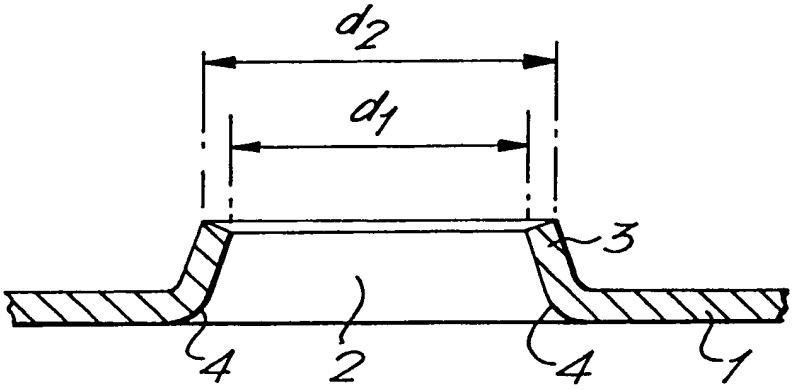
FIG.1.



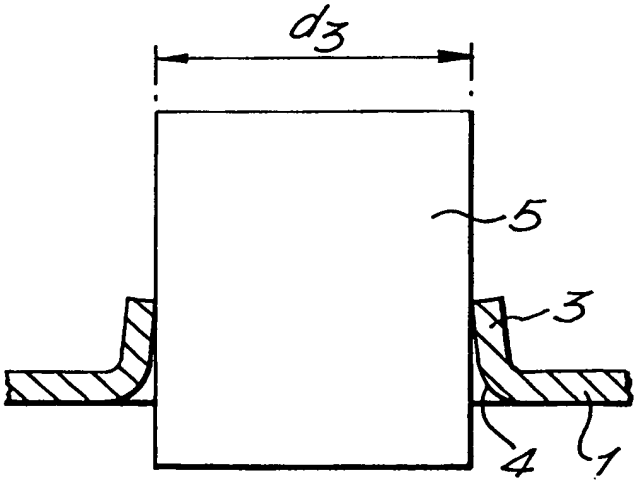




FIG.2.

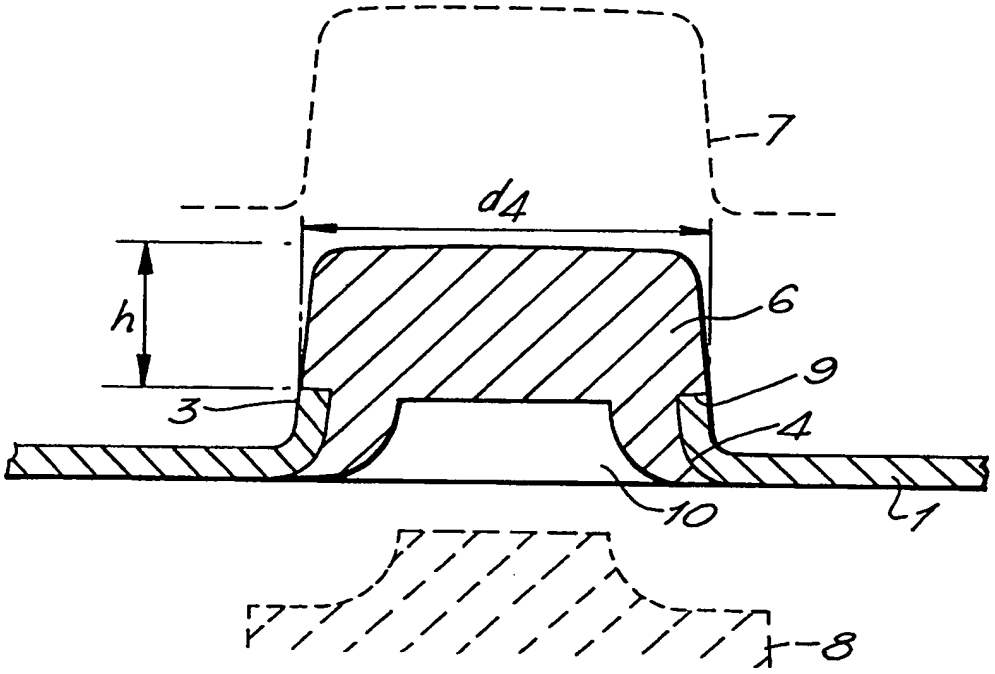



FIG.3.

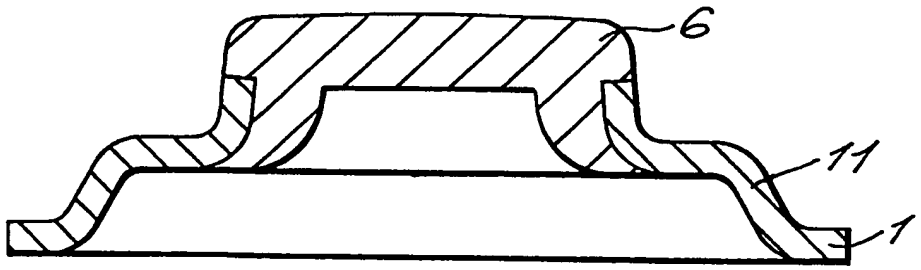



FIG.4.

# Electrical Contacts

The present invention relates to electrical contacts of the type having a contact member carried by a conductive strip member, and in particular, but not exclusively, to a method of manufacturing a contact wherein the contact member is formed of silver. The invention also relates to a novel electrical contact formed by such method

At the present time, a large number of silver contact constructions are known. Silver is particularly preferred as a contact material in view of its excellent electrical and thermal conductivity and because during use, the oxide coating formed on the contact is also electrically conductive. Fine silver ( 99.9% pure) is usually used to produce electrical contact faces since this grade of purity gives optimum properties of low electrical interface resistance, wear resistance, long life, current rating, minimum contact pressure, small size, formability etc. for a given cost. This grade of silver is the preferred alloy used in most applications. To give a harder contact member or one with improved weld resistance, particularly at higher temperatures, other materials such as nickel, copper or cadmium oxide may be alloyed with the silver. The term "silver" used hereinafter is intended to include both fine silver and silver alloys produced to alter the properties for specific applications.

Initially silver contact members were formed from silver wire formed into a contact head and shank, the shank being used to rivet the contact member on to a conductive strip member. However this led to unacceptable high usage of silver with high cost implications. This led to the development of composite contact members which comprised a silver contact facing

welded or diffusion bonded onto a copper backing and rivet shank. The contact member was then riveted onto a conductive strip member, as in the earlier construction. This type of contact member is widely used today, but is not as competitively priced as before in view of increased assembly costs relative to the price of silver.

More recently, it has been proposed to weld silver contact members directly on to a strip member. It is difficult to weld silver to certain strip members, such as beryllium copper (BeCu) leaf members, which are very commonly used, since BeCu gives a brittle, crystalline weld. Furthermore, the welding electrodes are normally of a material similar to BeCu. One proposal has been to provide a tape of silver with a suitable backing which is punched and trimmed and then fed automatically to be welded in place. However the machinery required to produce this type of contact is very expensive. Another machine has been developed which welds a silver wire directly to a strip member, for example of brass. However it is difficult to control the welding process to ensure consistent and satisfactory thermal and electrical contact between the silver contact and strip members. Furthermore, such machines are expensive and are not easily adaptable for differing contact sizes.

It has also been proposed by the present applicant to rivet a slug of silver wire directly into a hole provided in a BeCu strip leaf member. However it was found difficult to size the hole correctly to retain the slug in position between work stations, and to form the slug into a contact face without buckling the leaf member. Furthermore, since BeCu has a lower thermal conductivity than pure copper or silver and since the edge of the hole in the leaf in contact with the silver was relatively small, it was found that more silver than was necessary to account for contact wear was needed to absorb the heat generated by arcing when contact was

made and broken in use.

The present invention seeks to provide an improved method of manufacturing a contact and a contact made from such method.

In accordance with the present invention, there is provided a method of manufacturing an electrical contact of the type comprising a contact member carried by a conductive strip member, comprising forming an aperture defined by an upstanding rim in the strip member, locating a contact forming part in said aperture such that an interference fit is formed between the rim and the contact forming part, and press forming the contact forming part to provide a contact member of predetermined shape fixed within the aperture.

Thus in accordance with the invention, an aperture defined by an upstanding rim is first formed in the strip member. This may conveniently be done by first punching through the strip member and then drawing the edge of the aperture up to form the rim. The upstanding rim will not only act to stiffen the strip member in this region, but will also provide a relatively large surface area for contact with the contact member, as will be discussed further below. Typically in, for example, a 0.15mm thick strip member, the rim may be about 0.3mm high.

Although the invention may be applied to various contact member materials, the contact forming part is preferably of silver and most preferably of fine silver. Most conveniently the contact forming part may be formed from a wire of appropriate cross-section which may be cropped into a slug of suitable length, preferably before engagement with the strip member. The strip member may be manufactured from any of the commonly used materials such as brass, steel, phosphor bronze or beryllium copper.

In accordance with the invention the size of the contact forming part is chosen so as to be an

interference fit with the upstanding rim. Thus once the contact forming part is fitted in the strip, it may be moved to a further station for processing without becoming dislodged. It will be appreciated that any curvature at the base of the rim will ease the insertion of the contact forming part into the aperture, and will allow for variations in the size of the contact forming part as may occur in practice. Thus, an important advantage of the invention is that a contact forming part in the form of a simple wire slug may readily be guided into an interference fit within the aperture, without the need to maintain unacceptably close tolerances between the slug and aperture sizes to reliably achieve such fit, and the assembly thus formed can then be transported to a further station for press forming.

Preferably the rim tapers inwardly, which further facilitates insertion of the contact forming part into the aperture and also allows for wider tolerances.

The press forming of the contact member may be performed in a single or multistage operation. The final diameter of the contact member is preferably slightly larger than the initial outer diameter of the rim so as to allow for production tolerances and thus allow expansion of the rim during both the interference fitting with the contact forming part, and the subsequent press forming thereof. Thus the pressing die may have a diameter slightly larger than the upstanding rim whereby when the contact forming part is pressed, the outward pressure exerted by it on the inner surface of the rim forces the rim outwardly into contact with the die surface. Normally the contact forming part will be formed to extend to provide a contact surface above the upper edge of the rim, and preferably, after forming, it covers, preferably fully, the upper edge of the rim, and is preferably formed so as to lie flush with the outer surface of the rim. Furthermore, the

formed contact member preferably extends substantially along the length of the rim, whereby it is in contact with a large surface area of the strip member for improving thermal and electrical conduction into the strip. It will also be appreciated that since the contact member is pressed into contact with the rim under high pressure, good thermal and electrical conduction between them will be provided. Although the contact member is engaged with the strip member initially by an interference fit, after pressing it extends over the upper edge of the rim and along the tapering section of the rim, so that the contact member becomes mechanically keyed onto the strip member so that it will not loosen under thermal cycling and mechanical impact forces in use.

It will be appreciated that the invention allows a relatively small amount of contact material to be used to provide a satisfactory size of contact member. Where the contact member overlaps the upper edge of the rim as described above, the underlying rim automatically reduces the volume of contact material to give a particular diameter of contact member. The amount of material may be further reduced by press forming a recess in the base of the formed contact member. If it is desired to increase the distance between the contact surface and the strip member, the rim may be stepped or tiered either before or after engagement with the contact member. In a preferred form of the invention the contact member is press formed into engagement with the strip member by means of cooperating dies which provide a recess in the base of the contact member and simultaneously urge the contact material surrounding the recess outwardly into locking engagement with the rim.

The present invention extends to an electrical contact formed by the method of the invention. It also provides from a further aspect an electrical contact comprising a strip member having an aperture formed

therein defined by an upstanding rim, and a contact member press formed into engagement with the aperture. The contact may have the preferred features described earlier.

It will be appreciated that the invention may be employed to produce a fixed contact, in which the contact member is mounted on a comparatively rigid member, or a movable contact in which the contact member is mounted on a relatively flexible member. It is particularly suitable for producing contacts for use in domestic appliances or automobiles. It will also be apparent that at least in its preferred embodiments the invention will allow a substantial cost saving to be achieved, by virtue of a reduction in manufacturing costs as compared with producing conventional composites. For example, a multi-stage press tool may be used which as well as forming the contact member also cuts the strip member to its final shape. The strip member could be fed to the press tool from a coil, punched and drawn at a first station to define the rim, moved on to a second station, still attached to the coil, where the contact forming part is press fitted, moved to a third station at which the contact member is formed, and a final station at which the strip member is cut from the coil of material in the desired shape.

Some embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

Fig. 1 shows a strip member with an aperture formed therein;

Fig. 2 shows the strip member of Fig. 1 with a slug press-fitted into the aperture;

Fig. 3 shows a finished contact; and

Fig. 4 shows a further form of contact.

With reference to Fig. 1, a strip member 1 of BeCu is formed with a circular aperture 2 defined by an upstanding rim 3. An aperture is first punched in the

strip member and the edge of the aperture then drawn up by a suitable tool to form the rim 3. It will be seen that the rim tapers inwardly to respective minimum inner and outer diameter $d_1$, $d_2$, and that the base 4 of the rim provides a curved lead in to the taper.

As can be seen in Fig. 2, a circular cross-section contact forming part or slug 5 having an outside diameter $d_3$ which is greater than $d_1$ is then fitted into the aperture 2. The slug 5 forms an interference fit in the aperture 2, and is engaged with the aperture 2 from below the strip 1, the base 4 of the rim 3 acting as a guide to facilitate the initial location of the slug 5 within the aperture 2. The slug 5 is of silver which has been cropped from silver wire of suitable diameter. In practice, a wire diameter of 1.5mm may be used with say a strip thickness of 0.15mm. The slug 5 may be cropped from the wire either before or after it has been located in the aperture 2 in the strip member 1. The slug 5 is therefore held firmly in the strip member for subsequent operations performed on it, and the slug/strip assembly may be easily transferred to work stations without risk of the slug 5 being dislodged.

The slug 5 is then coined in a die or series of die stages to form the contact member 6 shown in Fig. 3, where the (final) die parts 7,8 are shown schematically with dotted lines. Prior to press forming, the slug 5 may be trimmed to a desired size or shape by any suitable method.

The maximum outer diameter $d_4$ of the contact member 6 is greater than the minimum outer diameter $d_2$ of the rim as shown in Fig. 1. During press forming, pressure from the die parts 7,8 squeezes the slug 5 such that it flows to fill the die space above the top edge 9 of the rim 3. The pressure of the slug 5 on the inner wall of the rim 3 forces the latter outwards completely to fill the die diameter. Continued pressure on the slug 5 makes it flow completely to fill the die, and so overlap

the upper edge 9 of the rim 3 and also the base 4 of the rim 3, as shown. The upper surface of the contact member 6 blends smoothly into the outer surface of the rim 3. The pressure exerted by the slug material 5 and the lateral support afforded by the die ensures a good thermal and electrical contact between the contact member 6 and strip member 1, without buckling the strip member 1. Also, there is a large area of contact between the contact member 6 and strip member 1 whereby heat can more easily be transferred to the strip member 1 from the contact member, thereby keeping the size of the contact member 6 as small as possible. Furthermore the contact member 6 is mechanically locked on the strip member 1 by virtue of the overlap with the rim edge 9 at one end and with the base region of the rim 4 at the other end, and it can thus better withstand thermal cycling and impact forces during use.

It will be seen that the presence of the rim 3 reduces the amount of contact material required for producing a contact member of a given diameter. This is further reduced by providing a recess 10 in the base of the contact member 6 as shown.

It will be appreciated that the required height h of the contact member 6 will be determined by the operating conditions to be experienced in use. In the embodiment shown, the overall contact height is 1mm, with the strip member being 0.15mm thick and the rim 3 upstanding approximately 0.3mm from the strip surface. Furthermore if in a particular application, it is found that the contact surface needs to be formed at a relatively large spacing from the strip 1, the rim 3 may be provided with a step 11, as shown in Fig. 4, so that a relatively small amount of material can be used in the contact 6 member itself.

It will be appreciated that many modifications may be made to the embodiment described above within the scope of the invention. For example, while there is

described the production of a single contact on a strip, a number of contacts may be produced on a sheet of strip material in the manner described above, and individual contacts then produced from that sheet.

Claims

1. A method of manufacturing an electrical contact of the type comprising a contact member carried by a conductive strip member, comprising forming an aperture defined by an upstanding rim in the strip member, locating a contact forming part in said aperture such that an interference fit is formed between the rim and the contact forming part, and press forming the contact forming part to provide a contact member of predetermined shape fixed within the aperture.

2. A method as claimed in claim 1 wherein said contact forming part is of silver.

3. A method as claimed in claims 1 or 2 wherein said contact forming part is formed from a wire of appropriate cross-section cropped into a slug of suitable length.

4. A method as claimed in claim 3 wherein said wire is cropped to length before engagement with the strip member.

5. A method as claimed in any preceding claim wherein said strip member is made of brass, steel, phosphor bronze or beryllium copper.

6. A method as claimed in any preceding claim wherein the rim tapers inwardly.

7. A method as claimed in any preceding claim wherein final diameter of the contact member is slightly larger than the initial outer diameter of the rim .

8. A method as claimed in any preceding claim wherein said contact forming part is formed to extend to provide

a contact surface above the upper edge of the rim.

9. A method as claimed in claim 8 wherein said contact forming part covers the upper edge of the rim.

10. A method as claimed in claim 8 or 9 wherein said contact forming member lies flush with the outer surface of the rim.

11. A method as claimed in any preceding claim wherein said contact forming member extends substantially along the length of the rim.

12. A method as claimed in any preceding claim wherein a recess is formed in the base of the formed contact member.

13. A method as claimed in claim 12 wherein the contact member is press formed into engagement with the strip member by means of cooperating dies which provide a recess in the base of the contact member and simultaneously urge the contact material surrounding the recess outwardly into locking engagement with the rim.

14. A method as claimed in any preceding claim wherein said rim is stepped.

15. An electrical contact comprising a strip member having an aperture formed therein defined by an upstanding rim, and a contact member press formed into engagement with the aperture.

16. An electrical contact as claimed in claim 15 wherein the contact member is of silver.

17. An electrical contact as claimed in claim 15 or 16 wherein said strip member is of brass, steel, phosphor

bronze or beryllium copper.

18. An electrical contact as claimed in claims 15, 16 or 17 wherein the rim tapers inwardly.

19. An electrical contact as claimed in any of claims 15 to 18 wherein said contact member extends to provide a contact surface above the upper edge of the rim.

20. An electrical contact as claimed in any of claims 15 to 19 wherein said contact member covers the upper edge of the rim.

21. An electrical contact as claimed in any of claims 15 to 20 wherein said contact member lies flush with the outer surface of the rim.

22. An electrical contact as claimed in any of claims 15 to 21 wherein said contact member extends substantially along the length of the rim.

23. An electrical contact as claimed in any of claims 15 to 22 wherein said contact member is provided with a recess in its base.

24. An electrical contact wherein said strip member is stepped in the region of the rim.

25. An electrical contact produced by a method as claimed in any of claims 1 to 14.

26. A method of manufacturing an electrical contact substantially as hereinbefore described with reference to the accompanying drawings.

27. An electrical contact substantially as hereinbefore described with reference to the accompanying drawings.

**Patents Act 1977**
**Examiner's report to the Comptroller under Section 17 (The Search Report)**

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**Relevant Technical fields**

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5 H01H, H01R

(ii) Int Cl (Edition )

Search Examiner
P CORBETT

**Databases** (see over)
(i) UK Patent Office

(ii)

Date of Search
8 OCTOBER 1992

Documents considered relevant following a search in respect of claims 1-27

| Category (see over) | Identity of document and relevant passages | | Relevant to claim(s) |
|---|---|---|---|
| X | GB 2101406 A | (ISKRA-SOZD) see lines 105-129 page 1 | 15,19,22, 23 |
| X | GB 2027275 A | (TAKANO) see Figure 7 | 15,16,19-22 |
| X | GB 1222293 | (LA CELLOPHANE) see lines 43-46 page 2 | 15,18,19 |
| X | GB 1128688 | (SEALECTRO) see lines 25-26 page 2 | 15,19,20, 22-24 |
| X | US 4563551 | (BLACK) see line 35 column 7 - line 8 column 9 | 1,3,4,6,7 11,12,15, 18,19,22, 23,25 |

| Category | Identity of document and relevant passages | Relevant to claim(s) |
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